DEPARTMENT OF MECHANICAL ENGINEERING
GEORGE R. BROWN SCHOOL OF ENGINEERING
RICE UNIVERSITY

MECH 310: RIGID BODY DYNAMICS (3 Credits)
Spring 2022

SECTION I. CONTACT INFORMATION

- Instructor: B.J. Fregly, Ph.D.
- Office: 203 Mechanical Engineering Building
- Email: fregly@rice.edu
- Office Hours:
  Tuesdays: 5:00 PM – 6:00 PM
  Wednesdays: 3:00 PM – 4:00 PM
  Thursdays: 11:00 AM – 12:00 NOON
- Teaching Fellows:
  Kendall Cooney kc78@rice.edu
  Prani Nalluri jy76@rice.edu
  Kimberly Rodriguez kr36@rice.edu
  Jason Ye jy76@rice.edu
- Zoom link for lectures:
  https://riceuniversity.zoom.us/j/92832636409?pwd=cDhUWXdlTGVlNHBIZ0FRSktQbGdzUT09
- Zoom link for office hours:
  https://riceuniversity.zoom.us/j/97331418775?pwd=TDZuWDVsSDN3aGw2Yzlmb2F3T3RRUT09

SECTION II. COURSE INFORMATION

- Pre-requisites: PHYS 101, PHYS 102, MATH 101, and MATH 102
- Lecture Schedule:
  Tuesdays and Thursdays: 9:25 AM – 10:40 AM
- Location:
  Ryon 201 and Zoom
- Required Textbook:
  Paul Mitiguy. Dynamics of Mechanical, Aerospace, and Bio/Robotic Systems. Prodigy Press, 2021.
  Includes MotionGenesis symbol manipulation software for equation derivation and numerical simulation.
  See Canvas for online ordering instructions.
- Reference Textbook:
  Thomas R. Kane and David A. Levinson. Dynamics: Theory and Applications. McGraw Hill Book Company, 1985.
  Available for free online at: https://ecommons.cornell.edu/handle/1813/638
  Helpful mainly for Kinematics, Mass Properties, and Forces/Equilibrium concepts.
- Teaching Philosophy:

If interested, you can read my teaching philosophy on my lab website:
http://rcnl.rice.edu/PDFs/teaching_philosophy.pdf

- Teaching Methodology:

  The instructor will utilize the whiteboard to write notes, express mathematical concepts, and solve example problems. Students are strongly encouraged to ask questions during class. The only dumb question is the question that you don't ask! Each lecture, the instructor will provide an outline of the concepts to be covered so that students will know where they are in the course material. Class notes will be posted on Canvas after each lecture.

- Course Description:

  Mechanics is the branch of the physical sciences that deals with the response of bodies to the action of forces and is based on the implementation of Newton's laws. This class focuses on Rigid Body Mechanics, which is subdivided into Statics and Dynamics. Statics is the study of bodies in equilibrium and is based on Newton's first and third laws, while Dynamics focuses on bodies in motion and is based on Newton's second and third laws.

- Course Objectives:

  The student will be equipped with the necessary mathematical tools and solution techniques to address any type of rigid body dynamics problem. In this regard, the student will gain an understanding of the basic principles that govern static equilibrium and dynamic motion of particles and rigid bodies under the action of forces and moments. In addition to learning manual derivation of the governing equations, students will learn the basics of numerical simulation of dynamic systems using equations derived with the aid of symbol manipulation software. Thus, in this course, you will learn not only how to derive the governing equations but also how to use them after you get them.

  By the end of this course, students should be able to:
  - Derive the governing equations defining static equilibrium and dynamic motion of rigid three-dimensional multibody systems
  - Model, introduce mathematical identifiers, analyze, and interpret dynamic systems
  - Understand the roles of analytical methods and computational tools
  - Develop intuition about the time-dependent nature of dynamic systems
  - Create and run dynamic simulations using professional software

- Absence Policy:

  The instructor is fully aware that the students participating in **university-sponsored** extracurricular activities may, on rare occasions, need to miss a lecture during the semester. In such cases, it is the student's responsibility to notify the instructor in advance to arrange make-up work and lectures.

- Topics Covered:

  The following four general topics will be covered, as outlined by Newton's Second Law $\mathbf{F} = m\mathbf{a}$:

  1. $\mathbf{a}$ - Kinematics

  2. m - Mass Properties

  3. $\mathbf{F}$ – Forces/Equilibrium

  4. $\mathbf{F} = m\mathbf{a}$ - Dynamics

  A more detailed list of topics, along with a detailed lecture schedule, will be provided at the first lecture.

SECTION III. GRADING POLICY

- Homework – 25%

  There will be approximately 16 Homework Assignments for this course, which will be due at the end of class on the days indicated in the Homework Assignments schedule. Students are required to follow the Homework Instructions provided by the instructor. All assignments must be uploaded to Canvas. Students are encouraged to work in groups to figure out how to solve homework problems, but each student must perform his or her own work to solve each problem. To provide you with greater flexibility during the pandemic, I will allow each student to submit *four* homework assignments up to one week late with no grade penalty. No prior notice need be given to the instructor when you choose to cash in a late homework. HOWEVER, MAKE EVERY EFFORT NOT TO GET BEHIND IN THE COURSE. If you get behind, you will have an extremely difficult time catching up later and doing well in the course.

- Course Project – 15%

  The last assignment will be a course project, where students will combine all of the knowledge and skills they have gained during the course to simulate the motion of a multibody dynamic system – the instructor kicking a soccer ball. The project will involve the use of MotionGenesis symbol manipulation software and a small amount of Matlab programming. You can start reading about the course project now on the Canvas course website. To provide greater flexibility during the pandemic, I will allow students to apply one of their homework lates to the course project instead with the caveat that the new submission date be no later than 3 days before final grades are due.

- Exams – 60% (In Person or Take Home to be determined)

  There will be 3 non-comprehensive exams throughout the semester (1 on Kinematics, 1 on Mass Properties and Forces/Equilibrium, and 1 on Dynamics). Each exam will be open book, open notes using only your course textbook, my lecture notes and handouts, and your own course notes and homework assignments. All work on exams must be completed individually, and no communication is permitted with others during exams.

  If you do not agree with the grading of a particular exam problem, you will have one week from the date the exam is returned to submit a written explanation of why you think the grade should be higher. However, the final decision will remain the instructor's.

  Exam 1 (20%) – Date to be determined
  Time: To be determined
  Location: To be determined

  Exam 2 (20%) Date to be determined
  Time: To be determined
  Location: To be determined

  Exam 3 (20%) – Date to be determined
  Time: To be determined
  Location: To be determined

- Share Your Life Story – 5%

  I have worked as a professor at two universities, and at both institutions students have been reluctant to come to office hours to get help from the professor when they needed it. To help you get over that hump in MECH 310, and to give me the chance to get to know you better, I am giving every student the option to come to my office hours once during the semester and spend at

least 5 minutes telling me your life story – where you grew up, your family background, what high school was like for you, how you ended up at Rice, what you like to do in your free time, what your life goals are, really anything that you would like to share about yourself. If you decide to share your life story with me, you will receive a grade of 100 for 5% of your course grade, with the remaining grade percentages listed above being scaled to total 95%.

- Attendance

  Students are expected to attend all lectures. Dynamics is a difficult topic, and it will be difficult to do well in this course unless you attend lectures regularly.

- Grading

  Course Grades:

A+	98-100
A	93-97.99
A-	90-92.99
B+	87-89.99
B	83-86.99
B-	80-82.99
C+	77-79.99
C	73-76.99
C-	70-72.99
D+	67-69.99
D	63-66.99
D-	60-62.99
F	below 59.99

  For individuals in the gray area between two grades, performance on homework assignments will be used to make the final decision.

SECTION IV. UNIVERSITY POLICIES

- Rice Honor Code:

  All student conduct associated with this course must comply with the Rice Honor System. While participation in study groups is strongly recommended, the work that you submit for grading must be your own. This policy applies to homework assignments and exams.

- Rice Disability Support:

  Any student with a disability requiring accommodations is encouraged to contact the instructor outside of class. Information regarding disability accommodations and other support can be obtained at http://www.dss.rice.edu/.

- Syllabus Policy:

  Information contained in the course syllabus, other than the Absence Policy, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor.